TACCIMO Climate Report Worksheet
Date: 4-2-2013
Location: Francis Marion National Forest
Climate Report Date: 4-1-2013 (1980-2009 reference period)
Analysis Focus: A2 (high) emissions scenario and near-term (2010-2039) time period

Overview
Climate projections at finer geographic and/or temporal scales come with greater uncertainty. For this reason, it is prudent to evaluate indications of less or more uncertainty in the model results. The following questions can be answered from the results of the TACCIMO Climate Report to provide a standardized approach to assess uncertainty and establish a basis for confidence in the discussion of model results.

Historic Climate—Evaluating GCM results with fine scale historic data helps establish a rationale when making comparisons, especially when absolute rather than relative values are important (e.g., considering a threshold for a temperature or moisture sensitive species or system). In general, a future GCM projection should only be directly compared to its own representation of historic climate. However, other historic climate data (in this case PRISM) based on observed climate at finer temporal and geographic scales may provide a more familiar representation of historic climate. As such, it is important to consider the GCM and PRISM (as well as other sources of climate data) to fully assess the potential implications of the projected change. It is also important to note that differences between the GCM and PRISM estimates of historic conditions do not by themselves indicate the skill (i.e., quality) of the GCM. Consider the following questions when comparing future with historic climate.

- How do observationally based historic climate estimates from PRISM compare with the historic median ensemble GCM for each variable and temporal resolution?
  - What is the difference between the GCM and PRISM historic estimates?
    - **Annual Temperature and Precipitation (table 1)**: GCM and PRISM historic estimates of temperature differ by 0.3F, with PRISM estimating 64.0 F and the median GCM estimating 64.4 F. GCM and PRISM historic estimates of precipitation differ by 0.3 inches, with PRISM estimating 50.9 inches and the median GCM estimating 51.2 inches.
    - **Seasonal Temperature and Precipitation (table 2):** GCM and PRISM historic estimates of seasonal temperature are most similar in the fall (differ by 0.1 F) and most different in the winter (differ by 0.9 F). GCM and PRISM historic estimate of seasonal precipitation are most similar in the spring (differ by 0.0 inches) and most different in the fall (1.0 inches).
  - If the differences are large (relative to the model uncertainty established for future projections), it may be worth exploring potential reasons (e.g., fine scale topographical influences lost in the coarser scale GCM projections)?
    - **Annual Temperature and Precipitation (table 1)**: The difference is generally less than the level of uncertainty associated with the annual future projections.
    - **Seasonal Temperature and Precipitation (table 2)**: The difference is generally less than the level of uncertainty associated with the seasonal future projections.

Future Projections—Examine future climate projections for the location of interest and consider the following questions to evaluate model results.

- How do the ensembles compare to one another for each variable and time period (including the historic baseline)?
  - What is the direction of change and range of the ensembles?
    - **Annual Temperature and Precipitation (table 3):** All of the projections indicate warming with annual average temperatures increasing by 1.9 F for the time period 2010-2039. Even the most conservative ensemble considered (25th percentile) estimates 1.7 F of warming during the 2010-2039 time period, which is greater than the 25th-75th percentile range of 0.5 F, which represents the level of model uncertainty during that time period. Precipitation projections indicate a generally wetter future, with median increase of 2.7% for the earliest time period considered (2010-2039). However, this change is within the 25th-75th percentile range of 4.0 in for 2010-2049, which represents the level of model uncertainty during that time period.
    - **Seasonal Temperature and Precipitation (table 4):** All seasons show warming, with the greatest change occurring in the winter (increase of 2.1 F) and the least change occurring in the winter (increase of 1.5 F) for the timer period 2010-2039. In all cases the projected changes are greater than the 25th-75th percentile range, which represent the level of model uncertainty. Seasonal precipitation projections indicate a trend toward a wetter fall with less pronounced changes in other changes. Only the fall increases are greater than the 25th-75th percentile range.

  - Does the range of the ensembles change over time?
    - **Annual Temperature and Precipitation:** The range for both temperature and precipitation increase over time, indicating increased model uncertainty over time.
    - **Seasonal Temperature and Precipitation:** With limited exceptions, the range for both temperature and precipitation increase over time, indicating increased model uncertainty over time.

  - How well does the direction and magnitude of change compare with other projections at different geographic (finer/ coarser) or temporal (finer/ coarser; future/ historic) scales?
    - Future projections considered are consistent with expectations found in the literature for the southern US for both annual and seasonal projections. Karl et al. (2009) discussed annual changes ranging from 4.5 F to 9 F by the 2080s for the B1 and A2 scenarios respectively. Sobolowski and Pavelsky (2012) found that seasonal temperatures would increase by 4.5 F in the summer and 3.2 F in the winter and spring by the time period 2040-2070.
    - Long-term monitoring on the Santee Experimental Forest found a statistically significant increase in air temperatures over the 63-year period from 1946-2008, with an average increase of ~0.3 F per decade (Dai et al. 2011). Mean annual daily minimum temperatures were found to increase at an even greater rate of ~0.5 F per decade (Dai et al. 2011). Changes in precipitation were small over the 63-year period; however, seasonally there was a slight increase in fall and winter rainfall and a decrease in spring and summer rainfall (Dai et al. 2011).

Table 1—Summary of mean annual historic and future climate (Girvetz et al. 2009; Maurer et al. 2007)

	Temperature						Precipitation								
	Absolute			Change			Absolute			Absolute Change			% Change		
	25th	**50th**	75th	25th	**50th**	75th	25th	**50th**	75th	25th	**50th**	75th	25th	**50th**	75th
	-------------------*degrees F*-------------------						---------------------*inches*---------------------						-----------%-----------		
1980-2009	64.9	**65.0**	65.3	-	-	-	49.3	**51.1**	52.1	-	-	-	-	-	-
2010-2039	66.0	**66.3**	66.5	1.1	**1.2**	1.1	50.5	**52.6**	54.5	1.2	**1.4**	2.3	2.5	**2.8**	4.5
2040-2069	67.9	**68.1**	68.3	3.0	**3.1**	3.0	51.3	**53.0**	54.8	2.0	**1.8**	2.7	4.2	**3.6**	5.1
2070-2099	69.9	**70.5**	71.1	5.0	**5.5**	5.8	48.8	**55.3**	56.4	-0.5	**4.2**	4.3	-1.0	**8.1**	8.2

Table 2—Summary of mean seasonal historic and future climate (Girvetz et al. 2009; Maurer et al. 2007)

		Temperature						Precipitation								
		Absolute			Change			Absolute			Absolute Change			% Change		
		25th	**50th**	75th	25th	**50th**	75th	25th	**50th**	75th	25th	**50th**	75th	25th	**50th**	75th
		-------------------*degrees F*-------------------						---------------------*inches*---------------------						-----------%-----------		
Winter	**1980-2009**	48.8	**49.1**	49.8	-	-	-	10.1	**10.6**	11.1	-	-	-	-	-	-
	2010-2039	49.8	**50.1**	50.7	1.0	**1.0**	0.9	10.1	**10.8**	11.6	0.0	**0.1**	0.5	0.5	**1.1**	4.1
	2040-2069	51.1	**51.6**	52.5	2.4	**2.5**	2.7	9.5	**10.7**	12.1	-0.6	**0.1**	1.0	-6.1	**0.5**	8.7
	2070-2099	52.9	**53.5**	54.3	4.2	**4.4**	4.5	9.9	**11.2**	12.3	-0.2	**0.5**	1.2	-2.3	**4.8**	10.4
Spring	**1980-2009**	64.2	**64.5**	64.9	-	-	-	10.2	**10.7**	11.2	-	-	-	-	-	-
	2010-2039	65.2	**65.6**	65.9	1.0	**1.1**	1.0	10.4	**11.1**	11.8	-0.8	**0.3**	0.4	2.6	**3.5**	4.7
	2040-2069	66.8	**67.4**	68.0	2.6	**2.9**	3.1	9.7	**10.5**	11.1	-1.8	**-0.5**	-0.2	-4.6	**-2.0**	-0.8
	2070-2099	69.1	**69.8**	70.5	4.9	**5.3**	5.6	9.1	**10.1**	11.1	-3.1	**-1.1**	-0.6	-10.4	**-5.7**	-1.0
Summer	**1980-2009**	79.9	**80.1**	80.4	-	-	-	17.3	**18.1**	18.8	-	-	-	-	-	-
	2010-2039	81.0	**81.3**	81.7	1.1	**1.2**	1.3	16.5	**18.1**	20.3	-0.8	**0.0**	1.5	-4.5	**0.1**	8.2
	2040-2069	83.0	**83.3**	83.8	3.1	**3.2**	3.4	16.1	**18.3**	20.6	-1.2	**0.3**	1.8	-7.2	**1.4**	9.8
	2070-2099	85.4	**85.9**	86.9	5.5	**5.8**	6.5	16.6	**18.8**	21.2	-0.7	**0.8**	2.4	-3.9	**4.2**	12.9
Fall	**1980-2009**	65.8	**66.1**	66.6	-	-	-	10.5	**11.2**	12.2	-	-	-	-	-	-
	2010-2039	67.1	**67.7**	67.9	1.3	**1.6**	1.3	11.0	**11.8**	13.3	0.5	**0.7**	1.0	4.4	**6.0**	8.6
	2040-2069	68.7	**69.5**	70.0	2.9	**3.3**	3.4	11.6	**12.5**	13.6	1.1	**1.3**	1.3	10.2	**11.4**	11.0
	2070-2099	71.1	**71.9**	73.0	5.3	**5.7**	6.4	11.8	**13.1**	14.3	1.3	**1.9**	2.0	12.2	**16.8**	16.6

Works Cited

Dai, Z., Amatya, D. M., Sun, G., Trettin, C. C., Li, C., & Li, H. 2011. Climate Variability and Its Impact on Forest Hydrology on South Carolina Coastal Plain, USA. Atmosphere, 2, 330-357. doi:10.3390/atmos2030330

Karl, T. R., Melillo, J. M., & Peterson, T. C. 2009. Global climate change impacts in the United States. New York, NY, USA: Cambridge University Press.

Sobolowski, S. & Pavelsky, T. 2012. Evaluation of present and future North American Regional Climate Change Assessment Program NARCCAP regional climate simulations over the southeast United States. Journal of Geophysical Research, 117D1, D01101+. doi: 10.1029/2011JD016430